SYSTEM AND METHOD FOR PROVIDING SERVO-CONTROLLED RESUSCITATION

This application is a divisional patent application of U.S. patent application Ser. No. 10/935,640, filed Sep. 8, 2004, which claims the benefit of U.S. provisional application Ser. No. 60/500,889, filed on Sep. 8, 2003, which are both incorporated herein by reference.

I. FIELD OF THE INVENTION

The present invention relates generally to resuscitation, and more particularly to providing automated servo-controlled resuscitation.

II. BACKGROUND OF THE INVENTION

Studies have indicated that hemorrhage is one of the leading causes of death in conventional warfare. For example, some officials believe that hemorrhage accounts for approximately fifty percent of deaths occurring on the battlefield. It has been noted that effective first aid and proper fluid resuscitation strategies could prevent some of these casualties from occurring.

Therefore, resuscitation systems have been developed. For example, a typical resuscitation system may include a resuscitation pump which an operator (for example, a medic) utilizes to pump some type of revitalization fluid into the patient. Such systems often suffer from a variety of disadvantages.

For instance, as fluid is pumped into a patient based on the patient's condition, such pumps are often employed with a physiological device that can be utilized to monitor a patient's vital signs as the patient's condition changes. For example, it may be determined that a particular patient requires fluid resuscitation when his or her blood pressure falls below a particular low level. Until the blood pressure falls below the low level, the operator does not need to operate the resuscitation pump.

Similarly, when the patient's blood pressure reaches a particular high level, the resuscitation pump should not be operated. Although the user does not need to continuously operate the pump, it is imperative that the user activates the pump precisely when it should be activated (for example, when the patient's blood pressure falls below the particular low level) and deactivates the pump precisely when it should be deactivated (for example, when the patient's blood pressure reaches the particular high level). Otherwise, serious health risks may occur. For example, if the blood pressure rises too high, then a blood clot may be dislodged and bleeding may increase. On the other hand, if the blood flow is not high enough, an ischemia/reperfusion injury can occur, thereby possibly leading to brain damage, heart attacks and injury to other vital organs such as the liver, kidneys, and lungs.

Thus, the user must constantly and carefully monitor the physiological device to precisely determine when to activate and deactivate the pump. Such a task can be burdensome, as the user (for example, a medic on the battlefield) may be simultaneously responsible for several patients. The resuscitation process occurs over a long period of time (for example, a few hours) and the patient's status will fluctuate during this time, thereby resulting in fatigue on the part of the user and serious repercussions for the patient.

Yet another one of the drawbacks of traditional resuscitation systems relates to failure of the pump to maintain the pumping rate/level at which it was programmed to pump. For instance, a variety of events may occur during operation of the pump that may cause the pumping rate of the pump into the patient to be altered. For example, an increased venous pressure may slow the pump flow rate of the resuscitation fluid, or the tube that transports fluid from its container to the pump may experience stretching, thereby impacting the accuracy of the pumping rate/level. Failure of the resuscitation pump to maintain the pumping rate/level may also lead to the above-referenced health effects. Other problems may also occur such as if a particular dose of the fluid is required, inaccurate pumping rate could lead to an overdose or underdose being given.

Therefore, in light of the foregoing, what is needed is an automated and accurate system for controlling resuscitation.

III. SUMMARY OF THE INVENTION

The present invention provides an automated system for controlling resuscitation in a patient. In at least one embodiment, the invention includes a fluid rate measurer, a pump, a physiological monitor, and a controller coupled to the fluid rate measurer, the pump, and the physiological monitor. The controller is adapted to receive signals transmitted by the physiological monitor and is capable of executing a servo control computer program module for controlling the resuscitation pumping to maintain those values of the desired physiological variable range and an error correction computer program module for performing error correction of the resuscitation pump based on a relation of an amount of fluid expected to be pumped and an amount of fluid that is actually pumped by the pump.

A method for controlling resuscitation of a patient connected to a physiological monitor, the method comprising: receiving a physiological signal from a physiological monitor, the physiological signal is indicative of a physiological variable, sending a pumping signal to a pump based upon whether the physiological variable is below a target range for the physiological variable, receiving a flow signal from a measuring device, the flow signal is indicative of the rate of resuscitation fluid is being pumped into the patient; and performing error correction of the pumping signal based on the difference between an amount of fluid expected to be pumped and an amount of fluid that is actually pumped.

In at least one embodiment, the invention further includes a calibration module for performing an initial fluid flow rate calibration to determine a relationship between pumping volume and pumping voltage. Such a calibration assists in assuring that the pump is accurately pumping.

IV. BRIEF DESCRIPTION OF THE DRAWINGS

The use of cross-hatching or shading within these drawings should not be interpreted as a limitation on the potential materials used for construction. Like reference numerals in the figures represent and refer to the same element or function.

FIGS. **1**A and **1**B illustrate block diagrams of exemplary systems of the present invention.

FIG. **2** illustrates a specific exemplary embodiment of the system of the present invention.

FIG. **3** illustrates a Graphical User Interface (GUI) depicting a servo-control resuscitation function according to at least one embodiment of the invention.

FIG. **4** illustrates an exemplary line graph visual display representing results of an actual test of the system of the present invention.

FIG. **5**A is a flow diagram illustrating exemplary steps of an aspect of the present invention.